JAPANESE [JP,07-111985,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS OPERATION EXAMPLE DESCRIPTION OF DRAWINGS DRAWINGS

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CLAIMS

[Claim(s)]
[Claim 1] Medical-application capsule equipment characterized by providing the elastic coupling means which combines two or more capsules and two or more of these capsules, a location detection means to detect the mutual physical relationship of two or more capsules, and the means of communications which transmits the detected relative physical relationship information to external means of communications.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention observes the part in a coelome directly, and relates to the medical-application capsule equipment which performs a diagnosis and a therapy.
[0002]
[Description of the Prior Art] Since it connects with external equipment in wireless when a patient understands from a patient's oral cavity unlike the endoscope inserted into a coelome, medical-application capsule equipment attracts attention by the pain given to a patient being greatly mitigable.
[0003] Medical-application capsule equipment can prescribe a drug solution for the patient, or can have the function to extract body fluid and an organization, and can prescribe a drug solution for the patient into a coelome, and can extract body fluid and an organization now so that it may be shown in the former, for example, JP,57-156736,A.
[0004] Moreover, recently, as shown in Japanese Patent Application No. No. 224180 [four to], in addition to the function mentioned above, a manipulator is formed in the body of a capsule, and what can deal with the affected part etc. positively is proposed.
[0005] By the way, although getting to know in which location in a coelome medical-application capsule equipment is prescribes a drug solution for the patient, or it extracts body fluid and an organization upwards and is an important thing Since conventional medical-application capsule equipment descends while Capsule b rolls the inside of Coelome a, for example, a lumen, as shown in drawing 12 (advance), it cannot judge to which direction it has turned [time amount / which has the capsule b itself / specific].
[0006] Moreover, as a U.S. Pat. No. 5,170,801 specification shows, for example, a means to catch energy, such as MAG which performs the localization by fluoroscopy diagnostic equipment, such as an X-ray and MRI, or the capsule itself emits, from the outside of the body is used.
[0007]
[Problem(s) to be Solved by the Invention] However, in conventional medical-application capsule equipment, in order to check the location in the coelome of a capsule, performing fluoroscopy by the X-ray has the problem of X-ray contamination, and it cannot perform the localization frequently.
[0008] Moreover, in fluoroscopy by MRI, in order to use a powerful magnetic field, magnetic-substance ingredients, such as an iron system metal, cannot be used for medical-application capsule equipment. Moreover, since MRI equipment is large-sized, it cannot carry out easily. Furthermore, by the method which catches outside a body the energy which the capsule itself emits, since only the positional information of one point is acquired, when a location is followed in time, predicting a motion of future correctly has the situation of being difficult.
[0009] That is, the path calculation approach of the conventional capsule is t1 and t2, as shown in drawing 13 . – It is t5. It is t6 by measuring one location of each capsule in time amount. When computing mathematically the location and rate of a capsule in time amount, polynomial approximation performs.
[0010]
[Equation 1]

t_n 時間での位置ベクトルを $\mathbf{X}n = (x_{1n}, x_{2n})$ で表わすと、

$t_1 \sim t_5$ 時間までの経路を表す多項式は、4次多項式

$$\mathbf{X}n = \mathbf{a} + \mathbf{b}\cdot tn + \mathbf{c}\cdot tn^2 + \mathbf{d}\cdot tn^3 + \mathbf{e}\cdot tn^4 \quad n=1\sim5 \text{---(1)}$$

で表わされ、$t_1 \sim t_5$ 時間の位置ベクトル $\mathbf{X}n$ ($n=1\sim5$) を

代入することによって、係数ベクトル $\mathbf{a}, \mathbf{b}, \mathbf{c}, \mathbf{d}, \mathbf{e}$

を求め、t_6 時間後の位置ベクトル $\mathbf{X}_6$ を式 (1) によって

求める。

[0011] Namely, t1 -t5 Using location data, although calculation by the 4th approximate polynomial is possible, the location of a capsule cannot be grasped correctly. This invention was made paying attention to said situation, and the place made into that purpose is to offer the medical-application capsule equipment which can predict a motion of a capsule in a high precision while being able to perform easily the localization of the capsule in a coelome which can be set correctly.

[0012]

[Means for Solving the Problem] In order to attain said purpose, having provided the elastic coupling means which combines two or more capsules and two or more capsules, a location detection means to detect the mutual physical relationship of two or more capsules, and the means of communications which transmits the detected relative physical relationship information to an external receiving means has this invention.

[0013]

[Function] By two or more capsules' being combined by the elastic coupling means, and forming location detection means, such as a strain gage, in this coupling means, each location of a capsule can be checked and, therefore, the relative location of the location of the capsule at the time of the next location measurement and two or more capsules can be predicted with a sufficient precision by mathematical approximation.

[0014]

[Example] Hereafter, each example of this invention is explained based on a drawing. Drawing 1 - drawing 3 show the 1st example, and drawing 1 shows the general drawing of medical-application capsule equipment. Medical-application capsule equipment consists of bond part material 3 as a coupling means which combines elastically the 1st capsule 1, 2nd capsule 2, and both capsules 1 and 2.

[0015] the 1st capsule 1 -- abbreviation -- it is spherical and the manipulator 5 for performing the observation optical system 4 as an observation means for observing the front and grasping of a body tissue, incision, and excision is formed in the anterior part. Furthermore, the sensor 6 which measures temperature in the living body and PH is formed in the posterior part of the 1st capsule 1. the 2nd capsule 2 -- abbreviation -- it is spherical and the means of communications 7 for communicating with external means of communications (not shown) is formed in the interior.

[0016] Said bond part material 3 is the rod-like structure which consists of a synthetic-resin ingredient which has elasticity, and the strain gage 8 as a location detection means can be attached in the pars intermedia, and it can know now the relative location of the 1st and the 2nd capsule 1 and 2 by detecting an elastic strain when the bond part material 3 is crooked.

[0017] Therefore, by swallowing the medical-application capsule equipment constituted as mentioned above from the oral cavity, in a coelome, about a lumen 9, as shown in drawing 1 , the 1st capsule 1 becomes anterior part, the 2nd capsule 2 becomes a posterior part, and the inside of a lumen 9 is gone on. It is in the middle of this advance, and the distorted information by the measurement data and the strain gage 8 of the observation image by the observation optical system 4, the temperature by the sensor 6, and PH is transmitted to external means of communications by means of communications 7. Moreover, means of communications 7 can receive the signal transmitted from external means of communications, a manipulator 5 can be operated according to this signal, and grasping of a body tissue, incision, excision, etc. can be performed.

[0018] Next, an operation of medical-application capsule equipment is explained. As shown in drawing 2 , by understanding from the oral cavity in order of the 1st capsule 1 and the 2nd capsule 2, the 1st capsule 1 becomes anterior part, the 2nd capsule 2 becomes a posterior part, and the inside of a lumen 9 is gone on. Since the 1st capsule 1 and 2nd capsule 2 are connected by the bond part material 3 at this time, free rotation is only a circumference of the axis of the capsule medial axis which ties the 1st and 2nd capsule 1 and 2 (arrow head), the medial axis and capsule medial axis of a lumen 9 are in agreement in general, and the anterior part of the 1st capsule 1 has always turned to the travelling direction.
[0019] Next, calculation of the path of a capsule is explained based on drawing 3 . Since the strain gage 8 is formed in the bond part material 3 and the relative-position relation between the 1st and the 2nd capsule 1 and 2 can be measured by the strain gage 8, the measurement tn time amount which is one day can be asked for the capsule location of two points. Therefore, tl -t5 The formula which searches for the multiplier vector of a polynomial based on the positional information in time amount can make ten, and, for this reason, can compute the multiplier vector of the 9th polynomial. Therefore, the location of the capsule of degree time amount can be predicted in a high precision by the polynomial of a higher order precision by the time amount measurement more nearly same than the conventional capsule.
[0020] Consequently, a diagnosis and a therapy can be performed more correctly. Moreover, since the anterior part of a capsule has always turned to the front of a lumen, it is easy to attach the orientation of an observation image, and AMBYURESHON in a desired part can be performed easily.
[0021] Drawing 4 - drawing 6 show the 2nd example, drawing 4 shows the condition that medical-application capsule equipment is running the inside of intestines 10, and drawing 5 shows one internal structure of the 1st and 2nd capsule 1 and 2 in the 1st example, and it only calls it a capsule 11 hereafter. A liquid is prepared in an ultrasonic vibrator 12 by one flank in the interior of this capsule 11 at a ******** room, and this ultrasonic vibrator 12 is supported by the ultrasonic motor 13 which performs a radial scan. Furthermore, the transmission-and-reception wave circuit 14 for performing the transmission-and-reception wave of a supersonic wave and the sending circuit 15 which transmits an ultrasonic picture signal to the outside of the body are established in the center section in the interior of a capsule 11, and the cell 16 for a capsule drive is formed in the flank also in the interior of a capsule 11.
[0022] A capsule 11 runs the inside of a coelome by peristalsis of an alimentary canal cavity, and transmits the ultrasonic tomogram in a coelome to the outside of the body serially. Outside a body, the external receiving set 17 as external means of communications shown in drawing 6 receives the signal from a capsule 11, and an ultrasonic image is displayed. The external receiving set 17 consists of the antenna 18 which receives an ultrasonic signal, a receiving circuit 19, the ultrasonic image generation circuit 20 which changes an input signal into a tomogram, a three-dimension supersonic-wave image construction circuit 21 which builds the obtained ultrasonic tomogram in a three-dimension image, and an image display display 22, and builds and displays the ultrasonic tomogram transmitted from the inside of a coelome on a three-dimension image.
[0023] Thus, by building and displaying outside a body the ultrasonic fault signal in the coelome transmitted from a capsule 11 on a three-dimension supersonic-wave image, with an ultrasonic probe and an endoscope, also including the body deep parts (small intestine etc.) which cannot reach, all alimentary canals are covered, a three-dimension tomogram is obtained, and a diagnosis of the useful data capture of physiological research or a lesion can be performed.
[0024] Drawing 7 shows the 3rd example, it is the block diagram of a capsule 11 and the external receiving set 17, and the acceleration sensor 23 which consists of piezoelectric devices in addition to the 2nd example is built in the capsule 11. the detecting signal of this acceleration sensor 23 is inputted into a sending circuit 14 -- having -- an ultrasonic wave-receiving signal -- Time Division Multiplexing -- or frequency multiplex is carried out and it is transmitted to the outside of the body.
[0025] In the external receiving set 17, an ultrasonic wave-receiving signal and an acceleration signal are separated in a receiving circuit. An acceleration signal is inputted into a location and the rate detector 24, and detects the location and rate of a capsule 11. Rate data are inputted into the three-dimension supersonic-wave image construction circuit 21, and an exact and legible three-

dimension image is obtained by performing three-dimension image construction corresponding to rate change of a capsule 11. Moreover, the location of the capsule 11 within a coelome can be known, without using an X-ray etc. with location data.

[0026] Thus, by having formed the acceleration sensor 23 in the capsule 11, the rate data of a capsule 11 amend three-dimension supersonic-wave image construction, and even when there is rate change of a capsule 11, an exact and legible image can be obtained. Moreover, the location of the capsule 11 in a coelome can be simply obtained with location data.

[0027] Drawing 8 (a) and (b) show the 4th example, show one internal structure of the 1st and 2nd capsule 1 and 2 in the 1st example, and only call it a capsule 31 hereafter. As shown in drawing 8 (a), in the container 32 which constitutes a capsule 31, the balun 33 of elasticity and the bellows 34 which is usually in a contraction condition are formed. It filled up with the drugs 35 made to emit to the interior of balun 33 by the affected part in the alimentary canal made into the purpose, and a role of a reservoir is played.

[0028] It connects with the free passage hole 36 of a container 32, and the end of balun 33 is opening inside and outside for free passage. On the other hand, the end of bellows 34 is also connected with the free passage hole 37 of a container 32, and the dissolution film 38 which dissolves in the free passage hole 37 alternatively with the digestive juices in an alimentary canal is formed. Moreover, the check valve 39 is formed in the free passage hole 37 so that a solution may permeate only into bellows 34 from the exterior of a capsule 31. Moreover, it fills up with the chemical 40 which causes the digestive juices and the science reaction in an alimentary canal to the lumen of bellows 34, and generates a gas (gas).

[0029] Thus, if the constituted capsule 31 is explained about the case where drugs are alternatively emitted within the stomach, it will consider as the matter which reacts the chemical 40 which constitutes said dissolution film 38 from gelatin digested with stomach juice, and is prepared in the lumen of bellows 34 with stomach juice (acid), and generates gas. as said chemical 40 -- a metal or CaCO(s)3, such as K, calcium, Na, Mg, aluminum, and Zn, etc. -- it is used.

[0030] If a patient swallows a capsule 31, the dissolution film 38 dissolves with the digestive juices 41, such as stomach juice, and as shown in drawing 8 (b), stomach juice infiltrates into the lumen of bellows 34 through a check valve 39. And gas 42, such as a lifting, hydrogen gas, and choke damp, generates the chemical 40 and chemical reaction in a capsule 31. In order to elongate bellows 34 and to press balun 33 with generating of gas 42, the drugs 35 with which the lumen of balun 33 was filled up are emitted in the stomach through the free passage hole 36.

[0031] On the other hand, when you carry out drugs emission within intestines, let the dissolution film 38 be the fatty-acid film digested with intestinal juice. Moreover, it is referred to as aluminum, Zn, Si, NH4 Cl, etc. which cause intestinal juice and a chemical reaction for the chemical 40 of the lumen of bellows 34, and generate gas.

[0032] And if a patient swallows a capsule 31 and a capsule 31 reaches in intestines, the dissolution film 38 which consists of fatty-acid film with intestinal juice will dissolve. And intestinal juice infiltrates into the lumen of bellows 34 through a check valve 39. And gas 42, such as a lifting, hydrogen gas, and ammonia gas, generates the chemical 40 and chemical reaction in a capsule 31, and in order to elongate bellows 34 and to press balun 33, the drugs 35 with which the lumen of balun 33 was filled up are emitted in intestines through the free passage hole 36.

[0033] Thus, since the constituted capsule prepared the chemical which generates gas in response to a bellows lumen with digestive juices (stomach juice, intestinal juice), it does not need to detect the location of a capsule with conventional X-ray imaging equipment, and needs to form neither a large-scale supersonic wave nor a magnetic generating means in the outside of the body, and can make drugs emit alternatively by the affected part made into the purpose in a coelome.

[0034] Drawing 9 (a) and (b) show the 5th example, attach the same number about the same component as the 4th example, and omit explanation. As shown in drawing 9 (a), a crevice 45 is established in the side face of the container 44 of a capsule 43, and this crevice 45 is opening the inside and outside of a container 44 for free passage through the free passage hole 46. The dissolution film 38 which dissolves with digestive juices is attached in the crevice 45. The adsorbent 47 which adsorbed gas is formed in the lumen of bellows 34. As this adsorbent 47, V, Mn, Cr, Co, etc. are used, for example. Moreover, the chemical 48 which the perimeter of the bellows 34 in a

container 44 causes digestive juices and a chemical reaction, and generates heat is formed.
[0035] Thus, if the constituted capsule 43 is explained about the case where drugs are alternatively emitted within the stomach, said dissolution film 38 will be constituted from gelatin digested with stomach juice, and the chemical 48 around bellows 34 will be set to alkali, NaOH, etc. which react with stomach juice (acid) and generate heat.
[0036] If a patient swallows a capsule 43, the dissolution film 38 dissolves with the digestive juices 41, such as stomach juice, and as shown in drawing 9 (b), stomach juice permeates into a container 44 through the free passage hole 46. And digestive juices 41 and the chemical 48 prepared in the perimeter of bellows 34 cause a chemical reaction, and generates heat. Dissociation emission of the gas 49 by which the adsorbent 47 was adsorbed by this generation of heat is carried out, and in order to elongate bellows 34 and to press balun 33, the drugs 35 with which the lumen of balun 33 was filled up are emitted in the stomach through the free passage hole 36.
[0037] On the other hand, when carrying out drugs emission within intestines, drugs will be alternatively emitted [chemical reaction / intestinal juice and] in intestines like acid, such as HCl which starts and generates heat, and CH3 COOH, then the above-mentioned in the chemical 48 which uses the dissolution film 38 as the fatty-acid film digested with intestinal juice, and prepares it in the perimeter of bellows 34.
[0038] Therefore, the same effectiveness as the 4th example is acquired. Drawing 10 (a) and (b) show the 6th example, attach the same number about the same component as the 4th and 5 example, and omit explanation. TiO2 which carried out platinum support at the wall of bellows 34 prepared in the interior of the container 51 of a capsule 50 as shown in drawing 10 (a) A particle 52 is fixed by adhesion etc., and is prepared and the lumen of bellows 34 is filled up with the electrolytic solution 53.
[0039] Bellows 34 is formed with the ingredient which has translucency. The chemical 54 which reacts with the digestive juices 41, such as intestinal juice, and emits light is formed in the perimeter of bellows 34. As this chemical 54, the mixture of a hydrogen peroxide or a hypochlorite, and luminol is used, for example.
[0040] Thus, if the constituted capsule 50 is explained about the case where drugs are alternatively emitted within intestines, a patient will swallow a capsule 50, and if it reaches in intestines, as the dissolution film 38 which consists of fatty-acid film dissolves and it is shown in drawing 10 (b), intestinal juice permeates into a container 51 through the free passage hole 46. And the chemical 54 which consists of intestinal juice, and luminol and hydrogen peroxide solution (hypochlorite) causes a lifting and 350-600nm luminescence for a chemical reaction.
[0041] This light is TiO2 in the bellows 34 of translucency. A particle 52 is reached and it is H2 and O2 by photoelectrolysis. Gas 55 occurs. And in order to elongate bellows 34 and to press balun 33, the drugs 35 with which the lumen of balun 33 was filled up are emitted in intestines through the free passage hole 36.
[0042] Therefore, the same effectiveness as the 4th and 5 example is acquired. Drawing 11 (a) and (b) show the 7th example, attach the same number about the same component as the 4-6th examples, and omit explanation. As shown in drawing 11 (a), the lumen of the bellows 34 prepared in the interior of the container 57 of a capsule 56 is filled up with the electrolytic-solution solution 58. As an electrolytic-solution solution 58, they are a sodium chloride and a copper chloride to water. What dissolved electrolytes, such as (II) and copper(II) sulfate, is used.
[0043] Moreover, the electrode 60 of a pair connected with the small dc-battery 59 at this is formed in the edge of bellows 34. It is immersed in the electrolytic solution 58 by the electrode 60 of a pair. Moreover, the timer switch 61 is formed in the periphery of a capsule 56, and the electrical potential difference of the small dc-battery 59 can be impressed between the electrodes 60 after setup-time progress.
[0044] Thus, if the constituted capsule 56 is explained about the case where drugs are alternatively emitted within the stomach and intestines, first, the timer switch 61 will be operated and the setup time of a timer will be made into the time amount to which a capsule 56 reaches the stomach or intestines. And the timer switch 61 is turned ON and a patient swallows a capsule 56. If a timer becomes the setup time, it will become switch-on and the electrical potential difference of the small dc-battery 59 will be impressed between the electrodes 60 of a pair.

[0045] By an electrical potential difference being impressed, an electrolytic solution 58 is electrolysis A lifting, H2, and O2 Gas 55 occurs. And in order to elongate bellows 34 and to press balun 33, the drugs 35 with which the lumen of balun 33 was filled up are emitted in the stomach or intestines through the free passage hole 36. Therefore, the same effectiveness as the 4-6th examples is acquired.

[0046]

[Effect of the Invention] As explained above, while being able to perform easily the localization of the capsule in a coelome which can be set correctly by establishing a location detection means to detect the mutual physical relationship of two or more capsules, and transmitting the detected relative physical relationship information to an external receiving means, while combining two or more capsules by the elastic coupling means according to this invention, a motion of a capsule can be predicted in a high precision.

[0047] Consequently, since the diagnosis and the therapy could be performed more correctly and the anterior part of a capsule has always turned to the front in a coelome, it is easy to attach the orientation of an observation image, and AMBYURESHON in a desired part can be performed easily.

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TECHNICAL FIELD

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PRIOR ART

[Description of the Prior Art] Since it connects with external equipment in wireless when a patient understands from a patient's oral cavity unlike the endoscope inserted into a coelome, medical-application capsule equipment attracts attention by the pain given to a patient being greatly mitigable.
[0003] Medical-application capsule equipment can prescribe a drug solution for the patient, or can have the function to extract body fluid and an organization, and can prescribe a drug solution for the patient into a coelome, and can extract body fluid and an organization now so that it may be shown in the former, for example, JP,57-156736,A.
[0004] Moreover, recently, as shown in Japanese Patent Application No. No. 224180 [four to], in addition to the function mentioned above, a manipulator is formed in the body of a capsule, and what can deal with the affected part etc. positively is proposed.
[0005] By the way, although getting to know in which location in a coelome medical-application capsule equipment is prescribes a drug solution for the patient, or it extracts body fluid and an organization upwards and is an important thing Since conventional medical-application capsule equipment descends while Capsule b rolls the inside of Coelome a, for example, a lumen, as shown in drawing 12 (advance), it cannot judge to which direction it has turned [time amount / which has the capsule b itself / specific].
[0006] Moreover, as a U.S. Pat. No. 5,170,801 specification shows, for example, a means to catch energy, such as MAG which performs the localization by fluoroscopy diagnostic equipment, such as an X-ray and MRI, or the capsule itself emits, from the outside of the body is used.

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EFFECT OF THE INVENTION

[Effect of the Invention] As explained above, while being able to perform easily the localization of the capsule in a coelome which can be set correctly by establishing a location detection means to detect the mutual physical relationship of two or more capsules, and transmitting the detected relative physical relationship information to an external receiving means, while combining two or more capsules by the elastic coupling means according to this invention, a motion of a capsule can be predicted in a high precision.
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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, in conventional medical-application capsule equipment, in order to check the location in the coelome of a capsule, performing fluoroscopy by the X-ray has the problem of X-ray contamination, and it cannot perform the localization frequently.
[0008] Moreover, in fluoroscopy by MRI, in order to use a powerful magnetic field, magnetic-substance ingredients, such as an iron system metal, cannot be used for medical-application capsule equipment. Moreover, since MRI equipment is large-sized, it cannot carry out easily. Furthermore, by the method which catches outside a body the energy which the capsule itself emits, since only the positional information of one point is acquired, when a location is followed in time, predicting a motion of future correctly has the situation of being difficult.
[0009] That is, the path calculation approach of the conventional capsule is t1 and t2, as shown in drawing 13 . — It is t5. It is t6 by measuring one location of each capsule in time amount. When computing mathematically the location and rate of a capsule in time amount, polynomial approximation performs.
[0010]
[Equation 1]
t_n 時間での位置ベクトルを $\mathbf{X}n = (x_{1n}, x_{2n})$ で表わすと、

$t_1 \sim t_5$ 時間までの経路を表す多項式は、4次多項式

$$\mathbf{X}n = a + b \cdot tn + c \cdot tn^2 + d \cdot tn^3 + e \cdot tn^4 \quad n=1\sim5 \text{---(1)}$$

で表わされ、$t_1 \sim t_5$ 時間の位置ベクトル $\mathbf{X}n$ ($n=1\sim5$) を

代入することによって、係数ベクトル a, b, c, d, e

を求め、t_6 時間後の位置ベクトル $\mathbf{X}_6$ を式 (1) によって

求める。

[0011] Namely, t1 -t5 Using location data, although calculation by the 4th approximate polynomial is possible, the location of a capsule cannot be grasped correctly. This invention was made paying attention to said situation, and the place made into that purpose is to offer the medical-application capsule equipment which can predict a motion of a capsule in a high precision while being able to perform easily the localization of the capsule in a coelome which can be set correctly.
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MEANS

[Means for Solving the Problem] In order to attain said purpose, having provided the elastic coupling means which combines two or more capsules and two or more capsules, a location detection means to detect the mutual physical relationship of two or more capsules, and the means of communications which transmits the detected relative physical relationship information to an external receiving means has this invention.

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OPERATION

[Function] By two or more capsules' being combined by the elastic coupling means, and forming location detection means, such as a strain gage, in this coupling means, each location of a capsule can be checked and, therefore, the relative location of the location of the capsule at the time of the next location measurement and two or more capsules can be predicted with a sufficient precision by mathematical approximation.

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EXAMPLE

[Example] Hereafter, each example of this invention is explained based on a drawing. Drawing 1 - drawing 3 show the 1st example, and drawing 1 shows the general drawing of medical-application capsule equipment. Medical-application capsule equipment consists of bond part material 3 as a coupling means which combines elastically the 1st capsule 1, 2nd capsule 2, and both capsules 1 and 2.
[0015] the 1st capsule 1 -- abbreviation -- it is spherical and the manipulator 5 for performing the observation optical system 4 as an observation means for observing the front and grasping of a body tissue, incision, and excision is formed in the anterior part. Furthermore, the sensor 6 which measures temperature in the living body and PH is formed in the posterior part of the 1st capsule 1. the 2nd capsule 2 -- abbreviation -- it is spherical and the means of communications 7 for communicating with external means of communications (not shown) is formed in the interior.
[0016] Said bond part material 3 is the rod-like structure which consists of a synthetic-resin ingredient which has elasticity, and the strain gage 8 as a location detection means can be attached in the pars intermedia, and it can know now the relative location of the 1st and the 2nd capsule 1 and 2 by detecting an elastic strain when the bond part material 3 is crooked.
[0017] Therefore, by swallowing the medical-application capsule equipment constituted as mentioned above from the oral cavity, in a coelome, about a lumen 9, as shown in drawing 1 , the 1st capsule 1 becomes anterior part, the 2nd capsule 2 becomes a posterior part, and the inside of a lumen 9 is gone on. It is in the middle of this advance, and the distorted information by the measurement data and the strain gage 8 of the observation image by the observation optical system 4, the temperature by the sensor 6, and PH is transmitted to external means of communications by means of communications 7. Moreover, means of communications 7 can receive the signal transmitted from external means of communications, a manipulator 5 can be operated according to this signal, and grasping of a body tissue, incision, excision, etc. can be performed.
[0018] Next, an operation of medical-application capsule equipment is explained. As shown in drawing 2 , by understanding from the oral cavity in order of the 1st capsule 1 and the 2nd capsule 2, the 1st capsule 1 becomes anterior part, the 2nd capsule 2 becomes a posterior part, and the inside of a lumen 9 is gone on. Since the 1st capsule 1 and 2nd capsule 2 are connected by the bond part material 3 at this time, free rotation is only a circumference of the axis of the capsule medial axis which ties the 1st and 2nd capsule 1 and 2 (arrow head), the medial axis and capsule medial axis of a lumen 9 are in agreement in general, and the anterior part of the 1st capsule 1 has always turned to the travelling direction.
[0019] Next, calculation of the path of a capsule is explained based on drawing 3 . Since the strain gage 8 is formed in the bond part material 3 and the relative-position relation between the 1st and the 2nd capsule 1 and 2 can be measured by the strain gage 8, the measurement tn time amount which is one day can be asked for the capsule location of two points. Therefore, t1 -t5 The formula which searches for the multiplier vector of a polynomial based on the positional information in time amount can make ten, and, for this reason, can compute the multiplier vector of the 9th polynomial. Therefore, the location of the capsule of degree time amount can be predicted in a high precision by the polynomial of a higher order precision by the time amount measurement more nearly same than the conventional capsule.
[0020] Consequently, a diagnosis and a therapy can be performed more correctly. Moreover, since

the anterior part of a capsule has always turned to the front of a lumen, it is easy to attach the orientation of an observation image, and AMBYURESHON in a desired part can be performed easily.

[0021] Drawing 4 - drawing 6 show the 2nd example, drawing 4 shows the condition that medical-application capsule equipment is running the inside of intestines 10, and drawing 5 shows one internal structure of the 1st and 2nd capsule 1 and 2 in the 1st example, and it only calls it a capsule 11 hereafter. A liquid is prepared in an ultrasonic vibrator 12 by one flank in the interior of this capsule 11 at a ******** room, and this ultrasonic vibrator 12 is supported by the ultrasonic motor 13 which performs a radial scan. Furthermore, the transmission-and-reception wave circuit 14 for performing the transmission-and-reception wave of a supersonic wave and the sending circuit 15 which transmits an ultrasonic picture signal to the outside of the body are established in the center section in the interior of a capsule 11, and the cell 16 for a capsule drive is formed in the flank also in the interior of a capsule 11.

[0022] A capsule 11 runs the inside of a coelome by peristalsis of an alimentary canal cavity, and transmits the ultrasonic tomogram in a coelome to the outside of the body serially. Outside a body, the external receiving set 17 as external means of communications shown in drawing 6 receives the signal from a capsule 11, and an ultrasonic image is displayed. The external receiving set 17 consists of the antenna 18 which receives an ultrasonic signal, a receiving circuit 19, the ultrasonic image generation circuit 20 which changes an input signal into a tomogram, a three-dimension supersonic-wave image construction circuit 21 which builds the obtained ultrasonic tomogram in a three-dimension image, and an image display display 22, and builds and displays the ultrasonic tomogram transmitted from the inside of a coelome on a three-dimension image.

[0023] Thus, by building and displaying outside a body the ultrasonic fault signal in the coelome transmitted from a capsule 11 on a three-dimension supersonic-wave image, with an ultrasonic probe and an endoscope, also including the body deep parts (small intestine etc.) which cannot reach, all alimentary canals are covered, a three-dimension tomogram is obtained, and a diagnosis of the useful data capture of physiological research or a lesion can be performed.

[0024] Drawing 7 shows the 3rd example, it is the block diagram of a capsule 11 and the external receiving set 17, and the acceleration sensor 23 which consists of piezoelectric devices in addition to the 2nd example is built in the capsule 11. the detecting signal of this acceleration sensor 23 is inputted into a sending circuit 14 -- having -- an ultrasonic wave-receiving signal -- Time Division Multiplexing -- or frequency multiplex is carried out and it is transmitted to the outside of the body.

[0025] In the external receiving set 17, an ultrasonic wave-receiving signal and an acceleration signal are separated in a receiving circuit. An acceleration signal is inputted into a location and the rate detector 24, and detects the location and rate of a capsule 11. Rate data are inputted into the three-dimension supersonic-wave image construction circuit 21, and an exact and legible three-dimension image is obtained by performing three-dimension image construction corresponding to rate change of a capsule 11. Moreover, the location of the capsule 11 within a coelome can be known, without using an X-ray etc. with location data.

[0026] Thus, by having formed the acceleration sensor 23 in the capsule 11, the rate data of a capsule 11 amend three-dimension supersonic-wave image construction, and even when there is rate change of a capsule 11, an exact and legible image can be obtained. Moreover, the location of the capsule 11 in a coelome can be simply obtained with location data.

[0027] Drawing 8 (a) and (b) show the 4th example, show one internal structure of the 1st and 2nd capsule 1 and 2 in the 1st example, and only call it a capsule 31 hereafter. As shown in drawing 8 (a), in the container 32 which constitutes a capsule 31, the balun 33 of elasticity and the bellows 34 which is usually in a contraction condition are formed. It filled up with the drugs 35 made to emit to the interior of balun 33 by the affected part in the alimentary canal made into the purpose, and a role of a reservoir is played.

[0028] It connects with the free passage hole 36 of a container 32, and the end of balun 33 is opening inside and outside for free passage. On the other hand, the end of bellows 34 is also connected with the free passage hole 37 of a container 32, and the dissolution film 38 which dissolves in the free passage hole 37 alternatively with the digestive juices in an alimentary canal is formed. Moreover, the check valve 39 is formed in the free passage hole 37 so that a solution may permeate only into

bellows 34 from the exterior of a capsule 31. Moreover, it fills up with the chemical 40 which causes the digestive juices and the science reaction in an alimentary canal to the lumen of bellows 34, and generates a gas (gas).
[0029] Thus, if the constituted capsule 31 is explained about the case where drugs are alternatively emitted within the stomach, it will consider as the matter which reacts the chemical 40 which constitutes said dissolution film 38 from gelatin digested with stomach juice, and is prepared in the lumen of bellows 34 with stomach juice (acid), and generates gas. as said chemical 40 -- a metal or CaCO(s)3, such as K, calcium, Na, Mg, aluminum, and Zn, etc. -- it is used.
[0030] If a patient swallows a capsule 31, the dissolution film 38 dissolves with the digestive juices 41, such as stomach juice, and as shown in drawing 8 (b), stomach juice infiltrates into the lumen of bellows 34 through a check valve 39. And gas 42, such as a lifting, hydrogen gas, and choke damp, generates the chemical 40 and chemical reaction in a capsule 31. In order to elongate bellows 34 and to press balun 33 with generating of gas 42, the drugs 35 with which the lumen of balun 33 was filled up are emitted in the stomach through the free passage hole 36.
[0031] On the other hand, when you carry out drugs emission within intestines, let the dissolution film 38 be the fatty-acid film digested with intestinal juice. Moreover, it is referred to as aluminum, Zn, Si, NH4 Cl, etc. which cause intestinal juice and a chemical reaction for the chemical 40 of the lumen of bellows 34, and generate gas.
[0032] And if a patient swallows a capsule 31 and a capsule 31 reaches in intestines, the dissolution film 38 which consists of fatty-acid film with intestinal juice will dissolve. And intestinal juice infiltrates into the lumen of bellows 34 through a check valve 39. And gas 42, such as a lifting, hydrogen gas, and ammonia gas, generates the chemical 40 and chemical reaction in a capsule 31, and in order to elongate bellows 34 and to press balun 33, the drugs 35 with which the lumen of balun 33 was filled up are emitted in intestines through the free passage hole 36.
[0033] Thus, since the constituted capsule prepared the chemical which generates gas in response to a bellows lumen with digestive juices (stomach juice, intestinal juice), it does not need to detect the location of a capsule with conventional X-ray imaging equipment, and needs to form neither a large-scale supersonic wave nor a magnetic generating means in the outside of the body, and can make drugs emit alternatively by the affected part made into the purpose in a coelome.
[0034] Drawing 9 (a) and (b) show the 5th example, attach the same number about the same component as the 4th example, and omit explanation. As shown in drawing 9 (a), a crevice 45 is established in the side face of the container 44 of a capsule 43, and this crevice 45 is opening the inside and outside of a container 44 for free passage through the free passage hole 46. The dissolution film 38 which dissolves with digestive juices is attached in the crevice 45. The adsorbent 47 which adsorbed gas is formed in the lumen of bellows 34. As this adsorbent 47, V, Mn, Cr, Co, etc. are used, for example. Moreover, the chemical 48 which the perimeter of the bellows 34 in a container 44 causes digestive juices and a chemical reaction, and generates heat is formed.
[0035] Thus, if the constituted capsule 43 is explained about the case where drugs are alternatively emitted within the stomach, said dissolution film 38 will be constituted from gelatin digested with stomach juice, and the chemical 48 around bellows 34 will be set to alkali, NaOH, etc. which react with stomach juice (acid) and generate heat.
[0036] If a patient swallows a capsule 43, the dissolution film 38 dissolves with the digestive juices 41, such as stomach juice, and as shown in drawing 9 (b), stomach juice permeates into a container 44 through the free passage hole 46. And digestive juices 41 and the chemical 48 prepared in the perimeter of bellows 34 cause a chemical reaction, and generates heat. Dissociation emission of the gas 49 by which the adsorbent 47 was adsorbed by this generation of heat is carried out, and in order to elongate bellows 34 and to press balun 33, the drugs 35 with which the lumen of balun 33 was filled up are emitted in the stomach through the free passage hole 36.
[0037] On the other hand, when carrying out drugs emission within intestines, drugs will be alternatively emitted [chemical reaction / intestinal juice and] in intestines like acid, such as HCl which starts and generates heat, and CH3 COOH, then the above-mentioned in the chemical 48 which uses the dissolution film 38 as the fatty-acid film digested with intestinal juice, and prepares it in the perimeter of bellows 34.
[0038] Therefore, the same effectiveness as the 4th example is acquired. Drawing 10 (a) and (b)

show the 6th example, attach the same number about the same component as the 4th and 5 example, and omit explanation. TiO2 which carried out platinum support at the wall of bellows 34 prepared in the interior of the container 51 of a capsule 50 as shown in drawing 10 (a) A particle 52 is fixed by adhesion etc., and is prepared and the lumen of bellows 34 is filled up with the electrolytic solution 53.

[0039] Bellows 34 is formed with the ingredient which has translucency. The chemical 54 which reacts with the digestive juices 41, such as intestinal juice, and emits light is formed in the perimeter of bellows 34. As this chemical 54, the mixture of a hydrogen peroxide or a hypochlorite, and luminol is used, for example.

[0040] Thus, if the constituted capsule 50 is explained about the case where drugs are alternatively emitted within intestines, a patient will swallow a capsule 50, and if it reaches in intestines, as the dissolution film 38 which consists of fatty-acid film dissolves and it is shown in drawing 10 (b), intestinal juice permeates into a container 51 through the free passage hole 46. And the chemical 54 which consists of intestinal juice, and luminol and hydrogen peroxide solution (hypochlorite) causes a lifting and 350-600nm luminescence for a chemical reaction.

[0041] This light is TiO2 in the bellows 34 of translucency. A particle 52 is reached and it is H2 and O2 by photoelectrolysis. Gas 55 occurs. And in order to elongate bellows 34 and to press balun 33, the drugs 35 with which the lumen of balun 33 was filled up are emitted in intestines through the free passage hole 36.

[0042] Therefore, the same effectiveness as the 4th and 5 example is acquired. Drawing 11 (a) and (b) show the 7th example, attach the same number about the same component as the 4-6th examples, and omit explanation. As shown in drawing 11 (a), the lumen of the bellows 34 prepared in the interior of the container 57 of a capsule 56 is filled up with the electrolytic-solution solution 58. As an electrolytic-solution solution 58, they are a sodium chloride and a copper chloride to water. What dissolved electrolytes, such as (II) and copper(II) sulfate, is used.

[0043] Moreover, the electrode 60 of a pair connected with the small dc-battery 59 at this is formed in the edge of bellows 34. It is immersed in the electrolytic solution 58 by the electrode 60 of a pair. Moreover, the timer switch 61 is formed in the periphery of a capsule 56, and the electrical potential difference of the small dc-battery 59 can be impressed between the electrodes 60 after setup-time progress.

[0044] Thus, if the constituted capsule 56 is explained about the case where drugs are alternatively emitted within the stomach and intestines, first, the timer switch 61 will be operated and the setup time of a timer will be made into the time amount to which a capsule 56 reaches the stomach or intestines. And the timer switch 61 is turned ON and a patient swallows a capsule 56. If a timer becomes the setup time, it will become switch-on and the electrical potential difference of the small dc-battery 59 will be impressed between the electrodes 60 of a pair.

[0045] By an electrical potential difference being impressed, an electrolytic solution 58 is electrolysis A lifting, H2, and O2 Gas 55 occurs. And in order to elongate bellows 34 and to press balun 33, the drugs 35 with which the lumen of balun 33 was filled up are emitted in the stomach or intestines through the free passage hole 36. Therefore, the same effectiveness as the 4-6th examples is acquired.

[Translation done.]

* NOTICES *

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The perspective view in which showing the 1st example of this invention and showing the advance condition in the lumen of medical-application capsule equipment.
[Drawing 2] The operation explanatory view of this example.
[Drawing 3] The explanatory view about calculation of the path of the capsule of this example.
[Drawing 4] The front view in which showing the 2nd example of this invention and showing the advance condition in the intestines of medical-application capsule equipment.
[Drawing 5] The vertical section side elevation of the capsule of this example.
[Drawing 6] The capsule of this example, and the block diagram of an external receiving set.
[Drawing 7] The 3rd example of this invention is shown and it is the block diagram of a capsule and an external receiving set.
[Drawing 8] The 4th example of this invention is shown and it is the vertical section side elevation of a capsule.
[Drawing 9] The 5th example of this invention is shown and it is the vertical section side elevation of a capsule.
[Drawing 10] The 6th example of this invention is shown and it is the vertical section side elevation of a capsule.
[Drawing 11] The 7th example of this invention is shown and it is the vertical section side elevation of a capsule.
[Drawing 12] The perspective view showing the advance condition in the lumen of conventional medical-application capsule equipment.
[Drawing 13] The explanatory view about calculation of the path of the conventional capsule.
[Description of Notations]
1 -- The 1st capsule
2 -- The 2nd capsule
3 -- Bond part material
7 -- Means of communications
8 -- Strain gage

[Translation done.]

* NOTICES *

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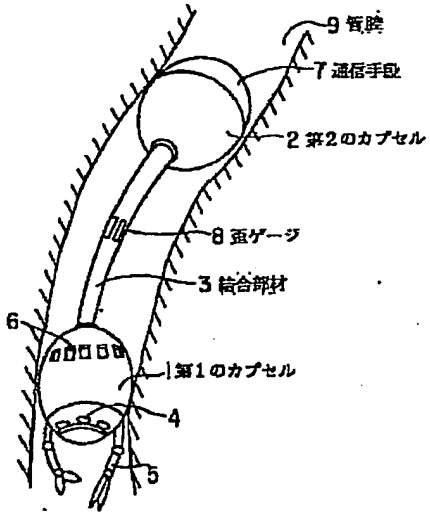
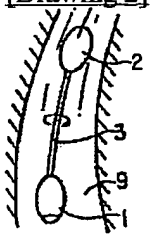
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

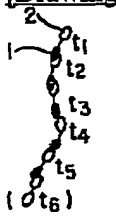
[Drawing 1]



[Drawing 2]



[Drawing 3]



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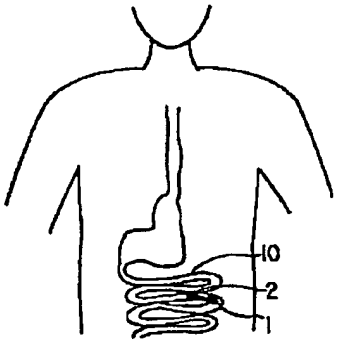

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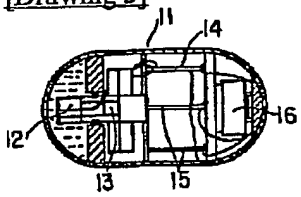

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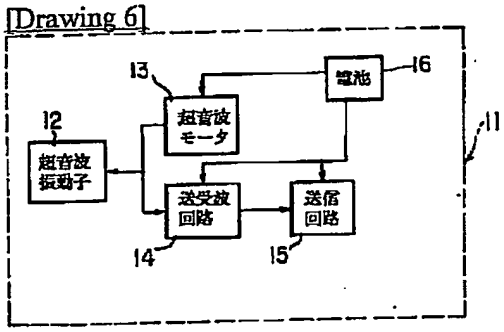
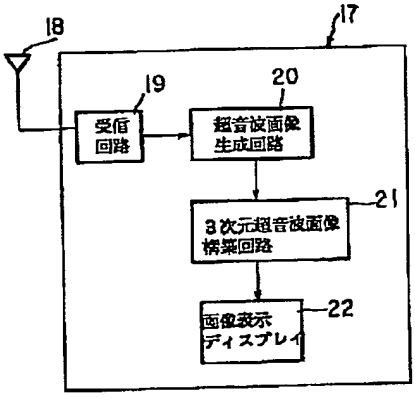
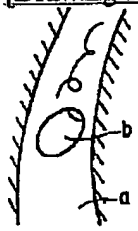
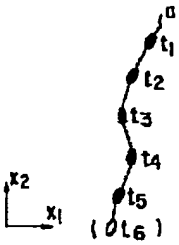




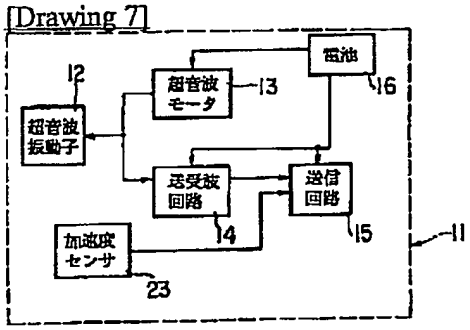
[Drawing 12]

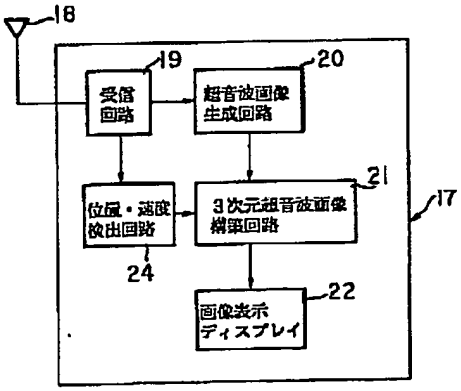


[Drawing 13]



[Drawing 7]





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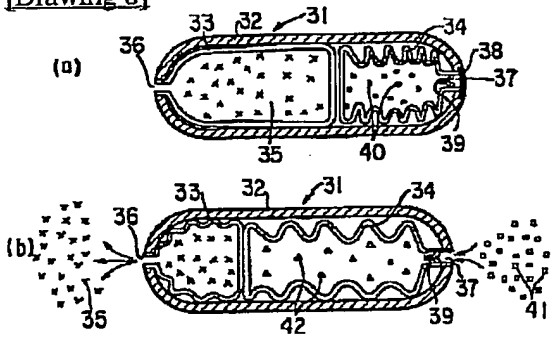

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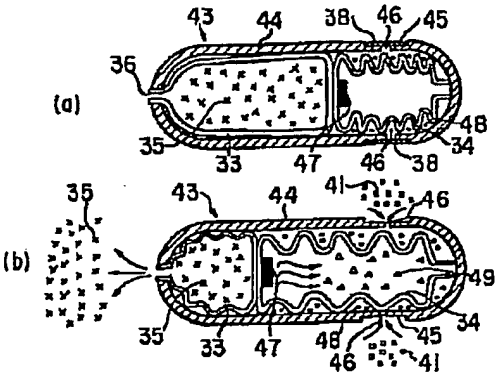

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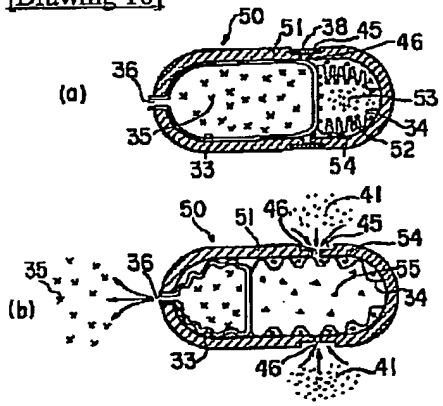
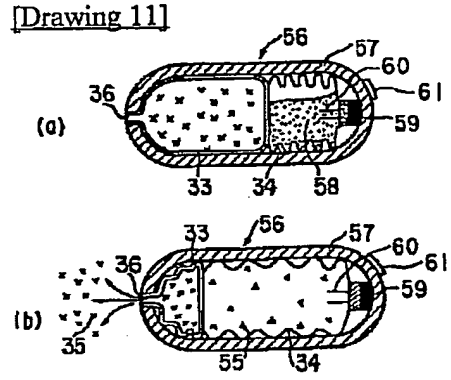


[Drawing 11]



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10/00	１０３　Ｆ			
Ａ６１Ｊ　3/07	Ａ			

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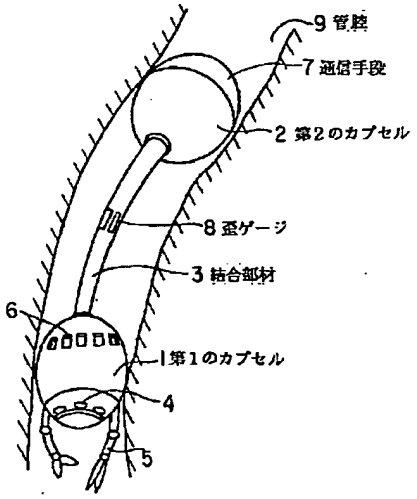
(54)【発明の名称】　医療用カプセル装置

(57)【要約】

【目的】　体腔内のおけるカプセルの位置確認を手軽に正確に行うことができると共に、カプセルの動きを高い精度で予測することができる医療用カプセル装置を提供することにある。

【構成】　第１のカプセル１と第２のカプセル２とを弾性的な結合部材３によって結合し、この結合部材３に歪ゲージ８を設け、第１と第２のカプセル１，２の互いの位置関係を検知すると共に、第２のカプセル２に検知した相対的な位置関係情報を体外通信手段へ送信する通信手段７を設けたことにある。



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【特許請求の範囲】

【請求項１】　複数個のカプセルと、この複数個のカプセルを結合する弾性的な結合手段と、複数個のカプセルの互いの位置関係を検知する位置検知手段と、検知した相対的な位置関係情報を体外通信手段へ送信する通信手段とを具備したことを特徴とする医療用カプセル装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】この発明は体腔内の部位を直接的に観察し、診断や治療を行う医療用カプセル装置に関する。

【０００２】

【従来の技術】医療用カプセル装置は、患者の口腔から体腔内に挿入する内視鏡とは異なり、患者が飲み込むことにより、体外装置と無線的に接続されているため、患者に与える苦痛を大きく軽減できることで注目されている。

【０００３】従来、例えば、特開昭５７－１５６７３６号公報に示すように、医療用カプセル装置は、薬液を投与したり、体液、組織を採取する機能を持っており、体腔内において薬液を投与し、また体液、組織を採取することができるようになっている。

【０００４】また、最近では、特願平４－２２４１８０号に示すように、前述した機能に加えてカプセル本体にマニピュレータを設け、患部等を積極的に処置することができるものも提案されている。

【０００５】ところで、医療用カプセル装置は、体腔内のどの位置にあるかを知ることは、薬液を投与したり、体液、組織を採取する上において重要なことであるが、従来の医療用カプセル装置は、図１２に示すように、体

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＊腔内、例えば管腔ａ内をカプセルｂが転動しながら下降（進行）していくため、カプセルｂ自身がある特定時間にどの方向を向いているのか判断できない。

【０００６】また、例えば米国特許第５，１７０，８０１号明細書で示すように、Ｘ線やＭＲＩ等の透視診断装置で位置確認を行うか、カプセル自身の発する磁気等のエネルギを体外から捕捉するという手段が用いられている。

【０００７】

【発明が解決しようとする課題】しかしながら、従来の医療用カプセル装置において、カプセルの体腔内の位置を確認するために、Ｘ線による透視を行うことはＸ線被爆の問題があり、頻繁に位置確認を行うことはできない。

【０００８】また、ＭＲＩによる透視では強力磁場を使用するために医療用カプセル装置に、鉄系金属などの磁性体材料は用いることができない。また、ＭＲＩ装置が大型であるため、手軽に行うことはできない。さらに、カプセル自身の発するエネルギを体外で捕捉する方式では１点の位置情報しか得られないために時間的に位置を追った時に、これからの動きの予測を正確に行うことは難しいという事情がある。

【０００９】すなわち、従来のカプセルの経路算出方法は、図１３に示すように、$t_1, t_2 \cdots t_5$ 時間でのそれぞれのカプセルの位置１点を測定することによって t_6 時間でのカプセルの位置および速度を数学的に算出する場合、多項式近似によって行う。

【００１０】

【数１】

t_n 時間での位置ベクトルを $X_n = (x_{1n}, x_{2n})$ で表わすと、

$t_1 \sim t_5$ 時間までの経路を表す多項式は、４次多項式

$$X_n = a + b \cdot t_n + c \cdot t_n^2 + d \cdot t_n^3 + e \cdot t_n^4 \quad n=1\sim5 \cdots (1)$$

で表わされ、$t_1 \sim t_5$ 時間の位置ベクトル X_n $(n=1\sim5)$ を代入することによって、係数ベクトル a, b, c, d, e を求め、t_6 時間後の位置ベクトル X_6 を式（１）によって求める。

【００１１】すなわち、$t_1 \sim t_5$ の位置データを用いて４次の近似多項式による算出が可能であるが、カプセルの位置を正確に把握することができない。この発明は、前記事情に着目してなされたもので、その目的とするところは、体腔内のおけるカプセルの位置確認を手軽に正確に行うことができると共に、カプセルの動きを高い精度で予測することができる医療用カプセル装置を提供することにある。

【００１２】

【課題を解決するための手段】この発明は前記目的を達成するために、複数個のカプセルと、複数個のカプセルを結合する弾性的な結合手段と、複数個のカプセルの互いの位置関係を検知する位置検知手段と、検知した相対的な位置関係情報を体外受信手段へ送信する通信手段とを具備したことにある。

【００１３】

【作用】複数のカプセルが弾性的な結合手段によって結合され、この結合手段に歪ゲージ等の位置検知手段を設

けることにより、カプセルのそれぞれの位置を確認することができ、よって次の位置測定時のカプセルの位置、複数個のカプセルの相対的位置関係を数学的近似によって精度良く予測することができる。

【００１４】

【実施例】以下、この発明の各実施例を図面に基づいて説明する。図１～図３は第１の実施例を示し、図１は医療用カプセル装置の全体図を示す。医療用カプセル装置は、第１のカプセル１と第２のカプセル２および両カプセル１，２を弾性的に結合する結合手段としての結合部材３とから構成されている。

【００１５】第１のカプセル１は、略球状で、その前部には前方を観察するための観察手段としての観察光学系４および生体組織の把持、切開、切除を行うためのマニピュレータ５が設けられている。さらに、第１のカプセル１の後部には生体内の温度、$_{F}$Hを測定するセンサ６が設けられている。第２のカプセル２も略球状で、内部には体外通信手段（図示しない）と交信するための通信手段７が設けられている。

【００１６】前記結合部材３は、弾性を有する合成樹脂材料等からなる棒状体で、その中間部には位置検知手段としての歪ゲージ８が取付けられ、結合部材３が屈曲されたときの弾性歪を検知することにより、第１と第２のカプセル１，２の相対的位置関係を知ることができるようになっている。

【００１７】したがって、前述のように構成された医療用カプセル装置を口腔から飲み込むことにより、体腔内、例えば管腔９を図１に示すように、第１のカプセル１が前部に、第２のカプセル２が後部になって管腔９内を進行する。この進行途中で、観察光学系４による観察像、センサ６による温度、$_{F}$Hの測定データおよび歪ゲージ８による歪情報は、通信手段７によって体外通信手段へ送信される。また、体外通信手段から送信された信号を通信手段７によって受信し、この信号に従ってマニピュレータ５を動作させることができ、生体組織の把持、切開、切除等を行うことができる。

【００１８】次に、医療用カプセル装置の作用について説明する。図２に示すように、第１のカプセル１、第２のカプセル２の順に口腔から飲み込むことにより、第１のカプセル１が前部に、第２のカプセル２が後部になって管腔９内を進行する。このとき、第１のカプセル１と第２のカプセル２が結合部材３によって連結されているため、自由な回転は、第１、第２カプセル１，２を結ぶカプセル中心軸の軸線回り（矢印）だけであり、常に管腔９の中心軸とカプセル中心軸は概ね一致しており、第１のカプセル１の前部は常に進行方向に向いている。

【００１９】次に、カプセルの経路の算出について図３に基づき説明する。結合部材３には歪ゲージ８が設けられているため、歪ゲージ８によって第１と第２のカプセル１，２の相対位置関係が測定できるため、１日の測定ｔｎ時間に２点のカプセル位置を求めることができる。したがって、t_1～t_n時間での位置情報を基に多項式の係数ベクトルを求める式は１０本作ることが可能であり、このため９次の多項式の係数ベクトルを算出できる。したがって、従来のカプセルよりも同じ時間計測によって、より高次の精度の多項式により次時間のカプセルの位置を高い精度で予測することができる。

【００２０】この結果、診断、治療をより正確に行うことができる。また、カプセルの前部が常に管腔の前方を向いているために観察像のオリエンテーションがつけ易く、また所望の箇所でのアンビュレーションを容易に行うことができる。

【００２１】図４～図６は第２の実施例を示し、図４は腸１０内を医療用カプセル装置が進行している状態を示し、図５は、第１の実施例における第１、第２のカプセル１，２の一方の内部構造を示し、以下、単にカプセル１１という。このカプセル１１の内部における一側部には液体を収容した室に超音波振動子１２が設けられ、この超音波振動子１２はラジアル走査を行う超音波モータ１３によって支持されている。さらにカプセル１１の内部における中央部には超音波の送受波を行うための送受波回路１４、超音波画像信号を体外に伝送する送信回路１５が設けられ、カプセル１１の内部における他側部にはカプセル駆動用の電池１６が設けられている。

【００２２】カプセル１１は消化管腔の蠕動により体腔内を進行し、逐次体腔内の超音波断層像を体外に送信する。体外では図６に示す、体外通信手段としての体外受信装置１７によりカプセル１１からの信号を受信して超音波画像を表示する。体外受信装置１７は超音波信号を受信するアンテナ１８、受信回路１９、受信信号を断層像に変換する超音波画像生成回路２０、得られた超音波断層像を３次元画像に構築する３次元超音波画像構築回路２１および画像表示ディスプレイ２２からなり、体腔内より伝送されてくる超音波断層像を３次元画像に構築して表示する。

【００２３】このようにカプセル１１から伝送される体腔内の超音波断層信号を体外にて３次元超音波画像に構築、表示することにより、超音波プローブ、内視鏡等では到達し得ない体深部（小腸等）も含め、消化管すべてに亘って３次元断層像が得られ、生理学的研究の有用なデータ獲得や病変の診断を行うことができる。

【００２４】図７は第３の実施例を示し、カプセル１１と体外受信装置１７のブロック図であり、カプセル１１には第２の実施例に加えて例えば圧電素子で構成されている加速度センサ２３が内蔵されている。この加速度センサ２３の検出信号は送信回路１４に入力され、超音波受波信号とともに時分割多重もしくは周波数多重され、体外に送信される。

【００２５】体外受信装置１７では受信回路にて超音波受波信号と加速度信号を分離する。加速度信号は位置・

速度検出回路２４に入力され、カプセル１１の位置・速度を検出する。速度データは３次元超音波画像構築回路２１に入力され、カプセル１１の速度変化に対応して３次元画像構築を行うことにより正確で見易い３次元画像が得られる。また、位置データによりＸ線等を使用せずに体腔内でのカプセル１１の位置を知ることができる。

【００２６】このように、カプセル１１に加速度センサ２３を設けたことにより、カプセル１１の速度データによって３次元超音波画像構築の補正を行い、カプセル１１の速度変化があった場合でも正確で見易い画像を得ることができる。また、位置データにより体腔内のカプセル１１の位置を簡易に得ることができる。

【００２７】図８（ａ）（ｂ）は第４の実施例を示し、第１の実施例における第１、第２のカプセル１，２の一方の内部構造を示し、以下、単にカプセル３１という。図８（ａ）に示すように、カプセル３１を構成する容器３２内には伸縮性のバルーン３３と通常は収縮状態にあるベローズ３４が設けられている。バルーン３３の内部には目的とする消化管内の患部で放出させる薬剤３５が充填され、リザーバとしての役割を果たしている。

【００２８】バルーン３３の一端は容器３２の連通孔３６と接続され、内外を連通している。一方、ベローズ３４の一端も容器３２の連通孔３７と接続され、連通孔３７には消化管内の消化液で選択的に溶解する溶解膜３８が設けられている。また、連通孔３７にはカプセル３１の外部からベローズ３４内のみに溶液が浸入してくるように逆止弁３９が設けられている。また、ベローズ３４の内腔には消化管内の消化液と科学反応を起こして気体（ガス）を発生する化学物質４０が充填されている。

【００２９】このように構成されたカプセル３１を胃内で選択的に薬剤を放出する場合について説明すると、前記溶解膜３８を胃液で消化されるゼラチン等で構成し、またベローズ３４の内腔に設ける化学物質４０を胃液（酸）と反応してガスを発生する物質とする。前記化学物質４０としては、Ｋ，Ｃａ，Ｎａ，Ｍｇ，Ａｌ，Ｚｎ等の金属あるいはＣａＣＯ，等が用いられる。

【００３０】患者がカプセル３１を飲み込むと、胃液等の消化液４１で溶解膜３８が溶解し、図８（ｂ）に示すように、胃液が逆止弁３９を介してベローズ３４の内腔に浸入する。そして、カプセル３１内の化学物質４０と化学反応を起こし、水素ガス、二酸化炭素ガス等のガス４２が発生する。ガス４２の発生に伴いベローズ３４は伸張し、バルーン３３を押圧するため、バルーン３３の内腔に充填された薬剤３５は連通孔３６を介して胃内に放出される。

【００３１】一方、腸内で薬剤放出をさせる場合は、溶解膜３８を腸液で消化される脂肪酸膜とする。また、ベローズ３４の内腔の化学物質４０を腸液と化学反応を起こしてガスを発生するＡｌ，Ｚｎ，Ｓｉ，ＮＨ，Ｃｌ等とする。

【００３２】そして、患者がカプセル３１を飲み込み、カプセル３１が腸内に到達すると、腸液により脂肪酸膜からなる溶解膜３８が溶解する。そして、腸液が逆止弁３９を介してベローズ３４の内腔に浸入する。そして、カプセル３１内の化学物質４０と化学反応を起こし、水素ガス、アンモニアガス等のガス４２が発生し、ベローズ３４は伸張し、バルーン３３を押圧するため、バルーン３３の内腔に充填された薬剤３５は連通孔３６を介して腸内に放出される。

【００３３】このように構成したカプセルは、ベローズ内腔に消化液（胃液、腸液）と反応してガスを発生する化学物質を設けたため、従来のＸ線造影装置でカプセルの位置を検出する必要はなく、また体外に大掛かりな超音波や磁気発生手段を設ける必要もなく、体腔内の目的とする患部で選択的に薬剤を放出させることができる。

【００３４】図９（ａ）（ｂ）は第５の実施例を示し、第４の実施例と同一構成部分については同一番号を付して説明を省略する。図９（ａ）に示すように、カプセル４３の容器４４の側面には凹部４５が設けられ、この凹部４５は連通孔４６を介して容器４４の内外を連通している。凹部４５には消化液で溶解する溶解膜３８が取付けられている。ベローズ３４の内腔にはガスを吸着した吸着剤４７が設けられている。この吸着剤４７としては、例えばＶ，Ｍｎ，Ｃｒ，Ｃｏ等が用いられる。また、容器４４内のベローズ３４の周囲は消化液と化学反応を起こして発熱する化学物質４８が設けられている。

【００３５】このように構成したカプセル４３を胃内で選択的に薬剤を放出する場合について説明すると、前記溶解膜３８を胃液で消化されるゼラチン等で構成し、またベローズ３４の周囲の化学物質４８を胃液（酸）と反応して発熱するアルカリ、ＮａＯＨ等とする。

【００３６】患者がカプセル４３を飲み込むと、胃液等の消化液４１で溶解膜３８が溶解し、図９（ｂ）に示すように、連通孔４６を介して胃液が容器４４内に浸入する。そして、消化液４１とベローズ３４の周囲に設けられた化学物質４８とが化学反応を起こして発熱する。この発熱により吸着剤４７に吸着されていたガス４９が解離放出され、ベローズ３４は伸張し、バルーン３３を押圧するため、バルーン３３の内腔に充填された薬剤３５は連通孔３６を介して胃内に放出される。

【００３７】一方、腸内で薬剤放出をさせる場合は、溶解膜３８を腸液で消化される脂肪酸膜とし、ベローズ３４の周囲に設ける化学物質４８を腸液と化学反応を起こして発熱するＨＣｌ，ＣＨ，ＣＯＯＨ等の酸性物質とすれば、前述と同様に腸内において選択的に薬剤が放出されることになる。

【００３８】したがって、第４の実施例と同様の効果が得られる。図１０（ａ）（ｂ）は第６の実施例を示し、第４，５の実施例と同一構成部分については同一番号を付して説明を省略する。図１０（ａ）に示すように、カ

ブセル５０の容器５１の内部に設けられたベローズ３４の内壁には白金担持したＴｉＯ₂粒子５２が接着等により固定して設けられ、ベローズ３４の内腔には電解液５３が充填されている。

【００３９】ベローズ３４は透光性を有する材料で形成されている。ベローズ３４の周囲には腸液等の消化液４１と反応して発光する化学物質５４が設けられている。この化学物質５４としては、例えば過酸化水素あるいは次亜塩素酸塩とルミノールの混合物が用いられる。

【００４０】このように構成したカプセル５０を腸内で選択的に薬剤を放出する場合について説明すると、患者がカプセル５０を飲み込み、腸内に到達すると、脂肪酸膜からなる溶解膜３８が溶解し、図１０（ｂ）に示すように、連通孔４６を介して腸液が容器５１内に浸入する。そして、腸液とルミノール、過酸化水素水（次亜塩素酸塩）からなる化学物質５４が化学反応を起こし、３５０～６００ｎｍの発光を起こす。

【００４１】この光は透光性のベローズ３４内のＴｉＯ₂粒子５２に届き、光電気分解によりH2，O2 ガス５５が発生する。そして、ベローズ３４は伸張し、バルーン３３を押圧するため、バルーン３３の内腔に充填された薬剤３５は連通孔３６を介して腸内に放出される。

【００４２】したがって、第４，５の実施例と同様の効果が得られる。図１１（ａ）（ｂ）は第７の実施例を示し、第４～６の実施例と同一構成部分については同一番号を付して説明を省略する。図１１（ａ）に示すように、カプセル５６の容器５７の内部に設けられたベローズ３４の内腔には電解液溶液５８が充填されている。電解液溶液５８としては水に塩化ナトリウム、塩化銅（ＩＩ），硫酸銅(II)等の電解質を溶解したものが用いられる。

【００４３】また、ベローズ３４の端部には小型バッテリー５９と、これに接続された一対の電極６０が設けられている。一対の電極６０は電解質溶液５８に浸漬されている。また、カプセル５６の外周にはタイマースイッチ６１が設けられ、設定時間経過後、電極６０間に小型バッテリー５９の電圧を印加可能となっている。

【００４４】このように構成したカプセル５６を胃内、腸内で選択的に薬剤を放出する場合について説明すると、まず、タイマースイッチ６１を操作してタイマーの設定時間をカプセル５６が胃あるいは腸に到達する時間にする。そして、タイマースイッチ６１をオンにし、患者がカプセル５６を飲み込む。タイマーは設定時間になると、スイッチオンとなり、小型バッテリー５９の電圧が一対の電極６０間に印加される。

【００４５】電圧が印加されることで、電解質溶液５８は電気分解を起こし、H2，O2 ガス５５が発生する。そして、ベローズ３４は伸張し、バルーン３３を押圧するため、バルーン３３の内腔に充填された薬剤３５は連通孔３６を介して胃内または腸内に放出される。したがって、第４～６の実施例と同様の効果が得られる。

【００４６】

【発明の効果】以上説明したように、この発明によれば、複数個のカプセルを弾性的な結合手段によって結合すると共に、複数個のカプセルの互いの位置関係を検知する位置検知手段を設け、検知した相対的な位置関係情報を体外受信手段へ送信することにより、体腔内のおけるカプセルの位置確認を手軽に正確に行うことができると共に、カプセルの動きを高い精度で予測することができる。

【００４７】この結果、診断、治療をより正確に行うことができ、またカプセルの前部が常に体腔内の前方を向いているために観察像のオリエンテーションがつけ易く、また所望の箇所でのアンビュレーションを容易に行うことができる。

【図面の簡単な説明】

【図１】この発明の第１の実施例を示し、医療用カプセル装置の管腔内の進行状態を示す斜視図。

【図２】同実施例の作用説明図。

【図３】同実施例のカプセルの経路の算出についての説明図。

【図４】この発明の第２の実施例を示し、医療用カプセル装置の腸内の進行状態を示す正面図。

【図５】同実施例のカプセルの縦断側面図。

【図６】同実施例のカプセルと体外受信装置のブロック図。

【図７】この発明の第３の実施例を示し、カプセルと体外受信装置のブロック図。

【図８】この発明の第４の実施例を示し、カプセルの縦断側面図。

【図９】この発明の第５の実施例を示し、カプセルの縦断側面図。

【図１０】この発明の第６の実施例を示し、カプセルの縦断側面図。

【図１１】この発明の第７の実施例を示し、カプセルの縦断側面図。

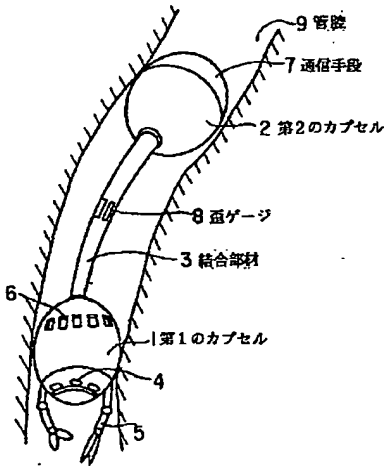
【図１２】従来の医療用カプセル装置の管腔内の進行状態を示す斜視図。

【図１３】従来のカプセルの経路の算出についての説明図。

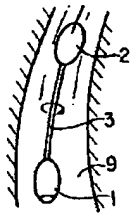
【符号の説明】

1…第１のカプセル
2…第２カプセル
3…結合部材
7…通信手段
8…歪ゲージ

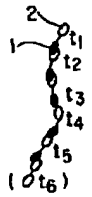
【図1】



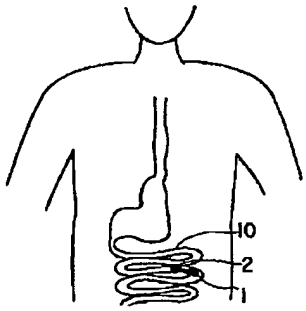
【図2】



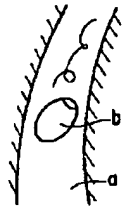
【図3】



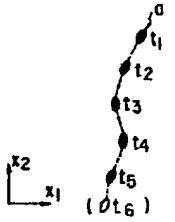
【図4】



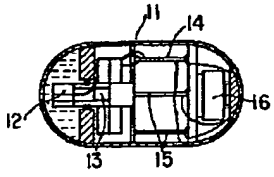
【図12】



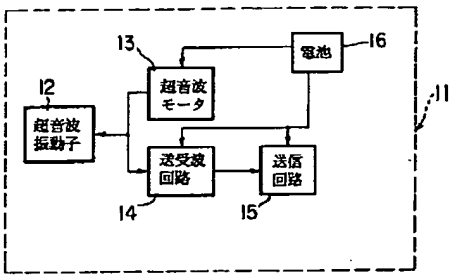
【図13】

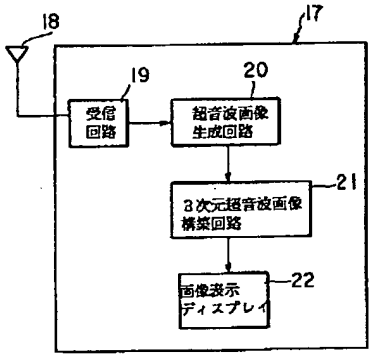


【図5】

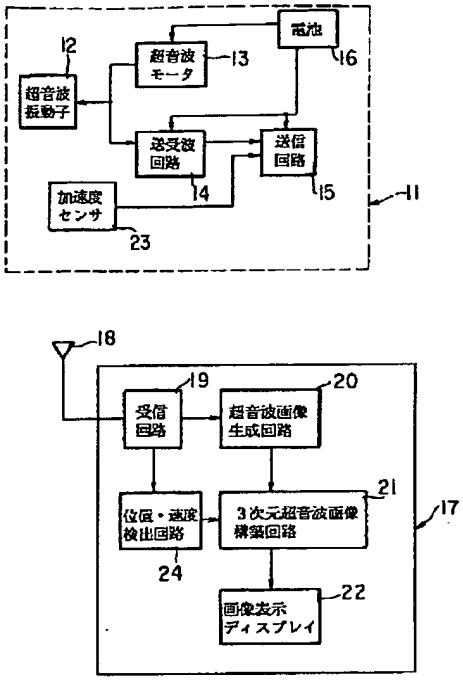


【図6】

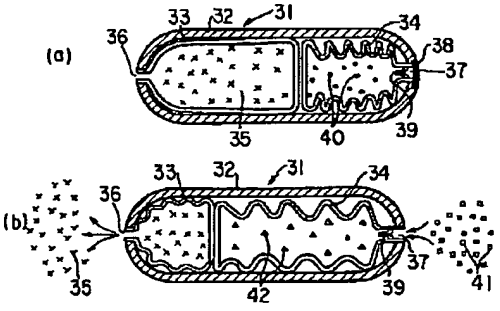




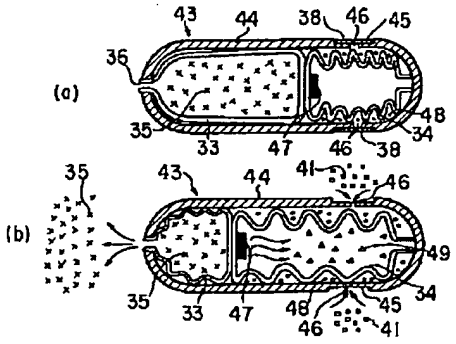
【図7】


電池
超音波モータ
超音波振動子
送受波回路
送信回路
加速度センサ
受信回路
超音波画像生成回路
位置・速度検出回路
3次元超音波画像構築回路
画像表示ディスプレイ

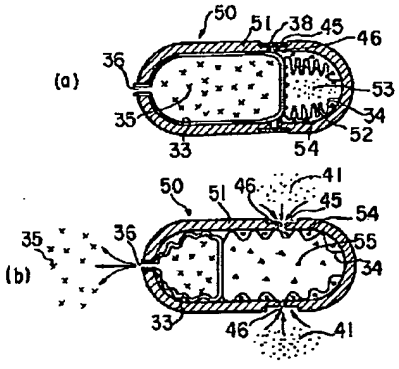
【図8】


(a)
(b)

【図9】


(a)
(b)

【図10】


(a)
(b)

【図11】